(3)

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER TOP 3-2-711	2. GOVT ACCESSION NO. AD-A122 176
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) US ARMY TEST AND EVALUATION COMMAND TEST OPERATIONS PROCEDURE "SAFETY EVALUATION - RADIOACTIVE COMPONENTS OF MATERIEL"	5. TYPE OF REPORT & PERIOD COVERED Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US ARMY ABERDEEN PROVING GROUND (STEAP-MT-M) ABERDEEN PROVING GROUND, MARYLAND 21005	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DARCOM-R 310-6
11. CONTROLLING OFFICE NAME AND ADDRESS US ARMY TEST AND EVALUATION COMMAND (DRSTE-AD-M) ABERDEEN PROVING GROUND, MARYLAND 21005	12. REPORT DATE 2 December 1982 13. NUMBER OF PAGES 11
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DTIC ELECTE DEC 7 1982 S B

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Radioactive Isotopes
Radioactive Materials
Safety - Radiation Protection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Describes procedures for evaluating the radiological safety of materiel components that emit ionizing radiation. Includes shock, vibration, and climatic tests and a test to determine whether combined storage will result in radiation or contamination.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

US ARMY TEST AND EVALUATION COMMAND
(TEST OPERATIONS PROCEDURE)

DRSTE-RP-702-102
*Test Operations Procedure 3-2-711 2 December 1982
AD No.

SAFETY EVALUATION - RADIOACTIVE COMPONENTS OF MATERIEL

1. SCOPE. This TOP describes safety evaluation tests of radioactive components of equipment (containing tritium luminous devices, radioactive cobalt, etc.) that will ultimately be released to troops. It provides procedures for evaluating (as part of development tests) the radiological safety of materiel components that emit ionizing radiation. This TOP does not cover other applicable safety considerations such as the extent to which fire or explosions might disperse radioactivity.

Some radioactive materials such as radium dials of compasses have been used for many years by the Army. Others such as depleted uranium, krypton, promethium, and tritium have been used only in recent years. Radioisotopes, if properly selected, used, encapsulated, and shielded, and suitably limited in activity, do not constitute a hazard to the health of test participants or ultimate troop users. The amount of radioisotope activity incorporated in materiel designed for troop use is usually low in comparison with the activity often found in manufacturing, medical, and research applications. Assurance must nevertheless be provided through tests that the item (as manufactured and following shock, vibration, and environmental exposures) does not release radioactive contamination.

*This TOP supersedes MTP 3-2-711 dated 9 June 1970.

Approved for public release; distribution unlimited.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM
Protective clothing and equipment as necessary
Decontamination equipment
Facility/equipment for isolating contamination
Calibration sources
Equipment for shock, vibration, and other environmental testing, as required

2.2 Instrumentation.

ITEM	MAXIMUM PERMISSIBLE ERROR OF MEASUREMENT*
Radiological air sampler	±10% of reading
Radiological swipe equipment	±10% of reading
Radiation-measuring equipment:	
Ionization chamber	±5% of reading
Geiger-Mueller counters	±5% of reading
Alpha-measuring instruments	±10% of reading
Beta-measuring instruments	±10% of reading
Liquid scintillation counter	±20% of reading

3. REQUIRED TEST CONDITIONS.

3.1 License for Radioactive Materials. Before accepting a shipment of radioactive material, using or conducting a test of materiel with radioactive components, qualified personnel and an appropriate Department of the Army authorization or US Nuclear Regulatory Commission (NRC) license must be obtained. Additionally, an SOP covering the handling, use, storage, and disposal of the radioactive materiel must be written before testing.

In all cases involving testing of any quantity of radioisotopes, approvals by the health physicist/radiation protection officer and the Radiation Protection Committee are required. The installation health physicist/radiation protection officer must be contacted immediately for guidance whenever a test involving radioisotopes is contemplated.

3.2 TECOM Policy. TECOM policy is as follows:

a. Test projects for items containing radioactive material must meet the following general requirements: any required NRC license or DA authorization must be obtained before using the materiel in tests; controls must be established for the safe testing of the materiel to prevent overexposure of personnel or accidental loss of radioactive materiel; and necessary tests must be conducted to determine the safety and health suitability of the materiel for Army use or issue. All such testing must be in compliance with AR 40-14, AR 385-11, DARCOM Supplement 1 to AR 40-5, DARCOM-R 385-25, and AR 700-64. Tests of packaged items

*Values may be assumed to represent ± 2 standard deviations; thus, the stated tolerances should not be exceeded in more than 1 measurement of 20.

must be designed to ensure that test procedures required by DOT (Title 49 CFR) are included. Test directives and/or test plans for suitability tests of such items will contain provisions for ensuring that the requirements in this TOP are met.

b. DARCOM Supplement 1 to AR 40-5 requires developers to obtain a hazard evaluation (performed by the US Army Environmental Hygiene Agency (AEHA)) 90 days before delivery of any radioactive source to this command (TECOM). AEHA requires at least five samples of each source for this evaluation, if available. After TECOM testing, AEHA again requires five items, if available, containing sources that have undergone TECOM testing to receive a final evaluation to determine if any probability exists that such sources might be a hazard to troop users.

3.3 Written Radiation Safety Appraisal. The installation health physicist/radiation protection officer is usually responsible for measuring the radiation emitted from the test item and evaluating its leakage and integrity characteristics before and after exposure to various shock and other environmental conditions. The data obtained will be compared with existing standards to provide assurance that the issuance of the test items will not constitute a hazard to troops.

Developing and testing agencies are responsible for identifying and evaluating health/safety hazards in new and modified items which contain radioactive materials. The AEHA findings will be included in appropriate safety verification actions. After AEHA performs the radiation measurement and analysis function, it will be necessary for the test agency to actually subject the test item to shock, vibration, and other environmental exposures because of the availability of facilities, familiarity with test procedures, and assignment of test responsibility. The report from the installation health physicist/radiation protection officer and AEHA will be made an appendix to the test activity's report.

3.4 Design Review. Review information obtained from developing agency or manufacturer for:

a. Radioisotope involved in the test
b. Amount of activity of radioisotope/test item
c. Manner of sealing or binding of radioisotope
d. All tests conducted to evaluate leakage, integrity, and similar data

NOTE: Headquarters, DARCOM, has instructed developers to provide technical information in safety assessment reports for any radioactive materiel submitted to TECOM for testing. TECOM test activities must ensure that the developer provides adequate safety instructions.

e. Adequacy of general content and safety instructions contained in technical manuals and other user instructions.

3.5 Separation of Radioactive Component. When a large item, e.g., a tank, has a component containing radioactive material, the developer should provide such item separately. If not, the component is usually removed from the item for exposure to selected conditions of paragraph 4. This will simplify the test and any decontamination problems that may arise.

3.6 Pre-test Inspection of Test Item.

a. Inspect radioactive items in accordance with the approved SOP (minimum approval: local Radiation Protection Committee) to include:

1) Required swipe tests
2) Required monitoring
3) Dose rate at surface, 1 ft from pallet, etc.

NOTE: Items showing excessive contamination (as defined in AR 385-11, Ionization Radiation Protection) due to poor sealing or other causes will ordinarily be returned to the manufacturer or test sponsor without undergoing the tests in paragraph 4.1, at the discretion of the health physicist/radiation protection officer and with the approval of the test director and sponsoring agency. The sponsor has the alternative of asking the test agency to dispose of the item as radioactive waste.

b. Record the following:

1) Visible signs of damage, corrosion, looseness, etc., including the radioisotope
2) Physical description of test item, source and its mount
3) Identifying nomenclature, part number, and/or drawing number
4) Date of inspection
5) Results of swipe tests and dose rate tests
6) Results of monitoring
7) Determination of the activity (if unknown) of the source from radiation measurements

4. TEST PROCEDURES. The test director, together with the health physicist/radiation protection officer and other consultants, will comply with test requirements of this TOP or notify Headquarters, TECOM Safety Office, when the TOP is not followed.

4.1 Shock, Vibration, and Climatic Tests. The most common shock, vibration, and climatic tests are listed in Table 1. The effect of various adverse environments on the radiological safety of the test item is determined by performing the following steps for each test phase:

a. Examine each test item for integrity. Measure and record area monitoring and swipe test results.
b. Subject the test item to one of the exposures of Table 1 requirements, as well as requirements documents or applicable specifications.

NOTE: The first tests that should be conducted are those in which contamination problems could most easily be handled and those involving radioactivity that might cause deterioration leading to discontinuation of the test program. Thus, tactical shock, high temperature, high humidity, fungus, and solar radiation exposures would ordinarily be first.

c. Following exposure, examine each test item under ambient conditions for damage and integrity. Measure and record monitoring and swipe test results.

4.2 General Rad-Safe Practices.

a. Test personnel will remain upwind of radioactive devices tested in the field if the radioactive material could be released. Inside testing will be conducted in a manner to protect all personnel in case a source breaks and releases its contents.

b. Swipe radioactive devices upon receipt, at the start/end of a test (see test instructions), and before any off-post shipment.

c. If source should indicate excess leakage, i.e., greater than 2220 DPM/swipe, all hands and clothing of affected personnel will be swiped. Swipes exceeding Table 4-3 of AR 385-11 will be brought to the attention of the local RPO.

d. All swipes will be numbered and recorded on rad survey report forms.

e. Broken or leaking sources will be disposed of only in accordance with AR 385-11.

f. All test personnel will wash their hands with soap and water after tests and before eating.

g. If a source should indicate gross leakage, i.e., 2220 DPM, bioassay will be performed IAW para 5-35, AR 40-5, by monitoring individuals for possible internal deposition of radioactive substance. Specimens will be forwarded by medical authority to the Commander, US Army Environmental Hygiene Agency (AEHA), ATTN: HSE-LR, Aberdeen Proving Ground, Md. 21010 (Autovon 584-2810).

h. Installation medical activities may provide bioassay specimens to AEHA. It may be more convenient to contract with a local laboratory for such help. Any contract should specify that the lab reports will also include the dose equivalent to the organ of interest for an infinite, yearly, and quarterly dose.

i. Written result of radiation survey for off-site radioactive material movement will be furnished to the transportation officer. Incoming shipment will be monitored and the documented results maintained by the radiation protection officer, in accordance with 10 CFR 20.205.

j. No repairs will be made to radioactive sources.

k. All test personnel will be informed of their rights and radiological hazards per 10 CFR 19.12.

l. Persons handling radioactive devices will be kept to a minimum.

m. Notify post radiation protection officer of receipt and storage of sources.

TABLE 1

SHOCK, VIBRATION, AND CLIMATIC EXPOSURES[a]

High temperature storage	Seven 24-hr cycles ranging from 34° to 68° C (93° to 155° F) per TOP 4-2-820.[1*] This is comparable to hot-dry climate of AR 70-38.[2]
Solar radiation	For items that may be in sun, follow procedures in TOP 4-2-826.[3]
Low temperature storage	-46° C (-50° F) as required by AR 70-38 for cold climates, for 3 days.
Temperature shock	Three cycles from 71° to -51° to 71° C (160° to -60° to 160° F), or 63° to -46° to 63° C (145° to -50° to 145° F) in accordance with MIL-STD-810, Method 503
High humidity	49° C (120° F) and 95% relative humidity for 360 hrs as described in TOP 4-2-820.
Temp-humidity cycling	Cycle from 21° to 41° to 21° C (70° to 105° to 70° F) at near saturation in accordance with TOP 4-2-820.
Transportation vibration	In accordance with TOP 1-2-601.[4]
12-meter drop	For packaged items, in accordance with TOP 4-2-601.[5] Items must not break; radioactive portion must not be jarred loose.
1.5-meter drop	For unpackaged items, in accordance with TOP 4-2-602.[6] Items must be undamaged and completely usable after drop.
2-meter drop	For packaged items, in accordance with TOP 4-2-602. Items must be undamaged and completely usable after drop.
Immersion	Immerse in distilled water at 41° C (105° F) for 24 hrs. Post-immersion inspection will include measurement of radioactivity of water (see Appendix B).
Salt spray	In accordance with MIL-STD-810.
Air delivery	Packaged items dropped at 8.7 m/s (28.5 fps) onto steel per TOP 4-2-602 is usually enough. Other tests are sometimes performed according to TOP 4-2-509.[7]
Loose cargo	In accordance with TOP 4-2-602.
Tactical shock	If the radioactive component is part of a shock-producing item such as a rifle, there must be repeated tests under the shock conditions.
Temperature/Altitude	Follow procedures of 10 CFR 32.101 which are extracted in Appendix B.
Accelerated weathering	Follow procedures of 10 CFR 32.101 which are extracted in Appendix B.

[a]May be altered by specifications.

*Footnote numbers correspond to reference numbers in Appendix A.

4.3 Storage Test. One consideration with respect to storage is that a quantity of like items combined for shipment may produce hazardous radiation even though one of the same items alone may not. A further complication arises when the radioisotope decays and emits a radioactive gas such as radon gas from radium. The hazards of radioactive gases accumulating in confined spaces such as in storage must be evaluated in such instances.

Storage may also result in leakage. Thus, some radioactive components may require contamination tests once each week until a suitable evaluation has been attained.

Because of the large variety of radioactive sources stored and used and their variation in configuration and intensity, it is impractical to stipulate specific procedures to cover all cases. The test director and the health physicist/radiation protection officer, the design agency and AEHA, as required, must determine on a case-by-case basis the exact procedures to follow. The three possible storage tests are:

a. Determination of radiation intensity around a package or group of packages containing the radioactive sources in their field-shipping configuration.

b. Determination, first by mathematical techniques, then by experimental methods, of the amount of radioactive gases that are emitted through radioactive decay.

c. Determination of the amount of contamination that is developed from sources as a result of migration, corrosion, or deterioration during extended storage.

5. DATA REQUIRED.

5.1 Shock, Vibration, and Climatic Tests. Record the following:

a. Type of exposure
b. Damage to test item
c. Amount of contamination and radiation before exposure
d. Conditions of exposure
e. Amount of contamination, radiation intensity, and damage following exposure

5.2 Storage Test. Record the following:

a. Description of packaging
b. Number of test items in storage configuration
c. Description of storage facility
d. For each measurement:

1) Date of measurement
2) Results of measurement (i.e., amount of radiation, contamination, radioactive gas)

6. DATA PRESENTATION. The data obtained will be compared with applicable standards, requirements, and specifications, and a radiological report will be

written to clearly assess the hazards, if any, associated with normal use of the test item.

The test agency health physicist/radiation protection officer or the AEHA will issue a radiological report to include any special provisions and precautions required to minimize or eliminate hazards to using personnel. This report will be made an appendix to the test activity's recommendation.

The test agency recommendation for safety release will include information on the characteristics of the radioisotope involved and any special requirements essential to safe employment of the test item. Additionally, it will include an assessment of the adequacy of technical literature furnished with the test item and recommendations for specific revisions required to ensure safe transport, use, and disposal (if appropriate) of the test materiel.

Recommended changes of this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, Md. 21005. Technical information may be obtained from the preparing activity: Commander, US Army Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, Md 21005. Additional copies are available from the Defense Technical Information Center Cameron Station, Alexandria, Va. 22314. This document is identified by the accession number (AD No.), printed on the first page.

APPENDIX A

REFERENCES

1. Test Operations Procedure (TOP) 4-2-820, Humidity Tests, 1 April 1979.

2. AR 70-38, Test and Evaluation of Materiel for Extreme Climatic Conditions, 1 August 1979.

3. TOP 4-2-826, Solar Radiation Tests, 15 October 1979.

4. TOP 1-2-601, Laboratory Vibration Schedules, 22 December 1980.

5. TOP 4-2-601, Drop Tower Tests for Munitions, 1 April 1979.

6. TOP 4-2-602, Rough Handling Tests, 1 April 1979.

7. TOP 4-2-509, Airdrop Capability of Explosive Materiel, 1 November 1972.

8. AR 40-14, Control and Recording Procedures for Exposure to Ionizing Radiation and Radioactive Materials, 15 March 1982.

9. AR 385-11, Ionizing Radiation Protection, 1 May 1980.

10. TECOM Supplement 1 to AR 40-5, Health and Environment, 3 August 1981.

11. DARCOM 385-25, Radiation Protection, 12 August 1968.

12. AR 700-64, Radioactive Commodities in the DoD Supply Systems, November 1976.

APPENDIX B
PROTOTYPE TESTS FOR*
LUMINOUS SAFETY DEVICES

Hermetic Seal and Waterproof Test. Upon completion of all other tests prescribed herein, the device shall be immersed in 76 cm (30 in) of water for 24 hours and shall show no visible evidence of water entry. Absolute pressure of the air above the water shall then be reduced to 2.5 cm of mercury. Lowered pressure shall be maintained for 1 minute or until air bubbles cease to be given off by the water, whichever is the longer. Pressure shall then be increased to normal atmospheric pressure. Any evidence of bubbles emanating from within the device, or water entering the device, shall be considered leakage.

Temperature/Altitude Test. The device shall be placed in a test chamber as it would be used in service. A temperature/altitude condition schedule shall be followed as outlined in the following steps:

1. The internal temperature of the test chamber shall be reduced to -62° C (-80° F), and the device shall be maintained for at least 1 hour at this temperature at atmospheric pressure.

2. The internal temperature of the test chamber shall be raised to -54° C (-65° F) and maintained until the temperature of the device has stabilized at atmospheric pressure.

3. The atmospheric pressure of the chamber shall be reduced to 83 mm of mercury absolute pressure while the chamber temperature is maintained at -54° C.

4. The internal temperature of the chamber shall be raised to -10° C (+14° F) and maintained until the temperature of the device has stabilized at -10° C, and the internal pressure of the chamber shall then be adjusted to atmospheric pressure. The test chamber door shall then be opened in order that frost will form on the device, and shall remain open until the frost has melted but not long enough to allow the moisture to evaporate. The door shall then be closed.

5. The internal temperature of the chamber shall be raised to 85° C (185° F) at atmospheric pressure. The temperature of the device shall be stabilized at 85° C and maintained for 2 hours. The device shall then be visually inspected to determine the extent of any deterioration.

6. The chamber temperature shall be reduced to 71° C (160° F) at atmospheric pressure. The temperature of the device shall be stabilized at 71° C for 30 minutes.

7. The chamber temperature shall be reduced to 55° C (130° F) at atmospheric pressure. The temperature of the device shall be stabilized at this temperature for 4 hours.

8. The internal temperature of the chamber shall be reduced to 30° C (86° F), and the pressure to 138 mm of mercury absolute pressure and stabilized. The device shall be maintained under these conditions for 4 hours.

*Source: 10 CFR 32.101 and 32.102, 1 August 1980.

9. The temperature of the test chamber shall be raised to 35° C (95° F) and the pressure reduced to 83 mm of mercury absolute pressure and stabilized. The device shall be maintained under these conditions for 30 minutes.

10. The internal pressure of the chamber shall be maintained at 83 mm of mercury absolute pressure, and the temperature reduced to 20° C (68° F) and stabilized. The device shall be maintained under these conditions for 4 hours.

Accelerated Weathering Tests. The device shall be subject to 100 hours of accelerated weathering in a suitable weathering machine/chamber. Panels of Corex D glass shall surround the arc to cut off the ultraviolet radiation below a wavelength of 2,700 angstroms. The light of the carbon arcs shall fall directly on the face of the device. The temperature of the sample shall be maintained at 50° C +3° (122° F). Temperature measurements shall be made with a black panel thermometer.